RESTRICTED CIRCULATION

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'Windchill' in lambs - background studies and forecasting trials in seasons 1980 - 81

Agricultural Memorandum No. 934

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'... there is hardly an expense equal to the effects both to fields and livestock, of a gnawing or destroying air'.

Bain (Quart. Journ. Agric 1839)

Lamb mortality during and soon after birth is thought to be a major source of loss to the world's sheep industry. Various recorded studies have been made in Australia, New Zealand and Scotland and some mortality figures are available from the Meat and Livestock Commission and MAFF surveys of commercial English lowland flocks. The indication is that on many farms lamb-losses from birth to 6 weeks are considerable - 20% or more.

As part of a study, in collaboration with the Veterinary Investigation Centre of MAFF Reading, to obtain detailed information on lamb mortality in a lowland flock in the south-east, meteorological observations were made at Rushall Farm, Bradfield near Reading between 1976 and 1979 (Purvis et al, 1979). These data were interpreted in terms of critical environmental heat demands leading to lamb field deaths; these 'critical' data were used in subsequent seasons in 'wind-chill' forecasting trials (Starr, 1980 and 1981).

Thermal comfort and stress in lambs

It is recognised (eg Blaxter 1962) that heat production in a homeotherm can increase in response to heat loss to the environment due to air movement and/or evaporation from the skin or coat or radiative losses. The environment becomes potentially lethal when head losses exceed 'summit metabolism' - the maximum rate of heat production that the animal can generate. This environmental heat demand will fluctuate from hour to hour and investigations on the electrical energy supply to 'model' animals (McArthur, 1980) and field observations (Sykes, 1976) imply that almost all new-born lambs are subject to cold stress which can be compounded by

low body reserves with which to meet the demand (Slee 1976).

Bradfield meteorological and veterinary studies

The studies were carried out at Rushall farm, Bradfield near Reading which lies between 100m and 60m height on a mainly south facing undulating slope leading down to the River Pang. The 1976 breeding flock consisted of 400 breeding ewes; by 1979 this number had been increased to 567.

All lamb casualties were submitted for autopsy, careful records being kept of dates and ages of death, ewe of origin, single, twin or triplet etc. Carcasses classified as field chilling/starvation showed general congestion of the viscera, especially the lungs, and in most cases stomachs were nearly empty. Most had used up body fat reserves.

Table 1 presents the percentage of total field and house lamb losses due to chilling/starvation in the field over the four years.

	1976	1977	1978	1979
Total ewes	400	486	550	567
Total lambs	745	943	1150	1133
Total field and houses losses	85	116	259	238
Chilling/starvation in the field (%)	6(7%)	20(17%)	36(14%)	77(32%)

Meteorological recordings at lamb height were made and mean hourly information on rainfall, wind-speed and temperature extracted. Data by Alexander (1964) provided the basis for expressing the environmental variables in terms of heat loss elicited from the young lamb. For example the heat loss from a young, dry short coated 2 kg lamb in still air at - 32°C is the same as for a dry lamb in a 5.5 m/s wind at an air temperature of + 13°C.

The data for 1978 and 1979 were analysed in detail and are discussed by Starr (1981).

They may be summarised as follows: some 60% of lamb deaths were attributable to days when the heat demand ($\bar{M}$) over 24 hours exceeded 80 times the metabolic rate (M_b) of a lamb in 'thermo neutral' (ie under 'non-stressed) conditions. 75% of deaths occurred when $\bar{M} > 70\ M_b$. Taking the total mortality of day-old lambs in 1979 on days with $\bar{M} > 80\ M_b$ we find the percentage mortality of light (< 3 kg), medium and heavy (> 5 kg) lambs to be 14.5, 5.2 and nil (expressed as a percentage of the respective populations of 48,171 and 35).

On one night 13/14 March 1979, 43% (6 of 14) of light lambs died - none of the heaviest succumbed. The practical implications seem to point to a daily value of 80 M_b being an appropriate 'high-risk' heat demand (the correspondingly 'night' value being 40 M_b). A trial 'wind-chill' forecasting scheme was established at Rushall in springs 1980 and 1981 with the co-operation of the Senior Meteorological Officers at Benson and Upavon and Mr Bishop, Farm Manager.

The Wind-chill forecasting trial

Early in 1980 Mr Pettit visited Bradfield to study how the local topography might modify the Benson forecasts. A forecasting pro-forma was designed.

Using Alexander's (1964) data tables of averaged heat loss were drawn up (table 2) for wet and dry lambs under the number of expected temperature and wind speed ranges, allowance being made particularly for requirement that forecasts should apply to 'lamb height'; (eg experiments established a fairly constant relationship between the 10 m Benson wind-speed and lamb height at Bradfield).

The 24 hours beginning 0800 local time were divided into six 4-hourly periods for which temperatures, wind-speeds and the occurrence or not of rain were forecast. 'Wind-chill' indices were estimated from the tables and totalled, categories of risk being assigned as indicated (Fig. 1, 2). During the March and April trial period indices were passed daily, on request, to Mr Bishop (Table 3).

DISCUSSION

In 1981 Mr Bishop followed these forecast ratings of 'wind-chill' explicitly, putting out triplet lambs only if M< 70, twins at M: 70-80. Only singles were put out if M>80 and in severe weather (M>95) even the strong singles were retained in-house for a period (weakling stock were allocated to fields offering reasonable shelter).

Over the 1981 season 12 field deaths occurred out of 1000 lambs (ie about 1%); in particular on the severe night of 21 March no fatalities occurred at Rushall Farm while an elevated farm near Marlborough reported 45 deaths. Upavon forecasted the highest 'wind-chill' (99) of the trial for that night (Table 4) and Mr Bishop reacted accordingly.

In view of the importance of a wet lamb coat to heat loss digressions of 'actual' from 'forecast' chill factor can be attributed primarily to uncertainties in forecasting the onset and finish of precipitation over the 4-hour periods.

Mr Bishop has further drawn attention to a few occasions when high humidity and low winds during 'dry' periods have caused the lamb coat to remain moist. Future forecasts will thus allow for continuing coat wetness under appropriate conditions.

Summary

These preliminary results are sufficiently encouraging to suggest that wind chill forecasts have an operational potential, certainly for the lowland flock for which housing or shelter can be made available. A further trial extended to 4 farms with large sheep enterprises and offering a range of 'exposures' is planned for 1982.

Acknowledgements

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Any comments or suggestions on this paper to be referred to:

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Reading
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Fig 1

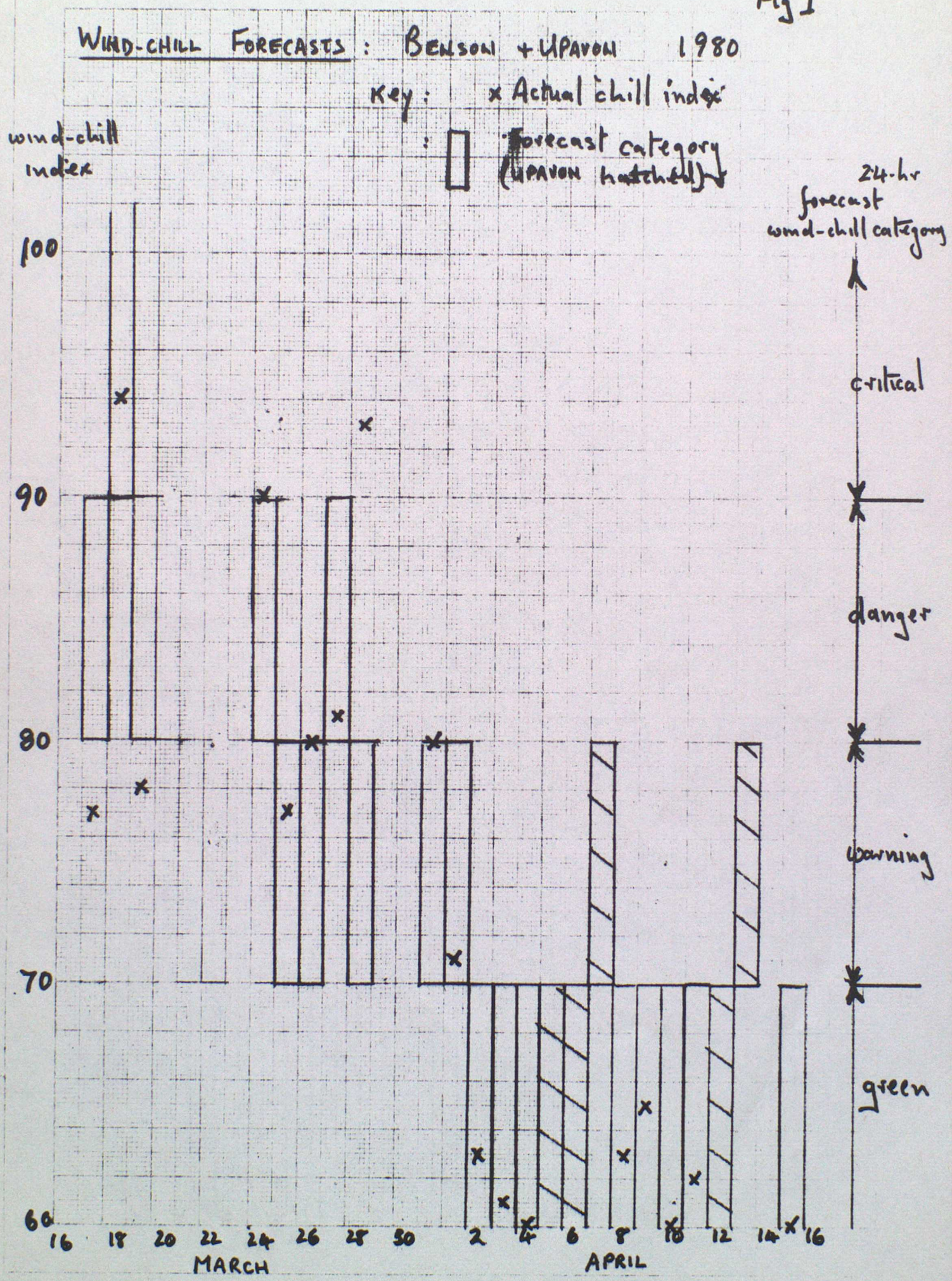
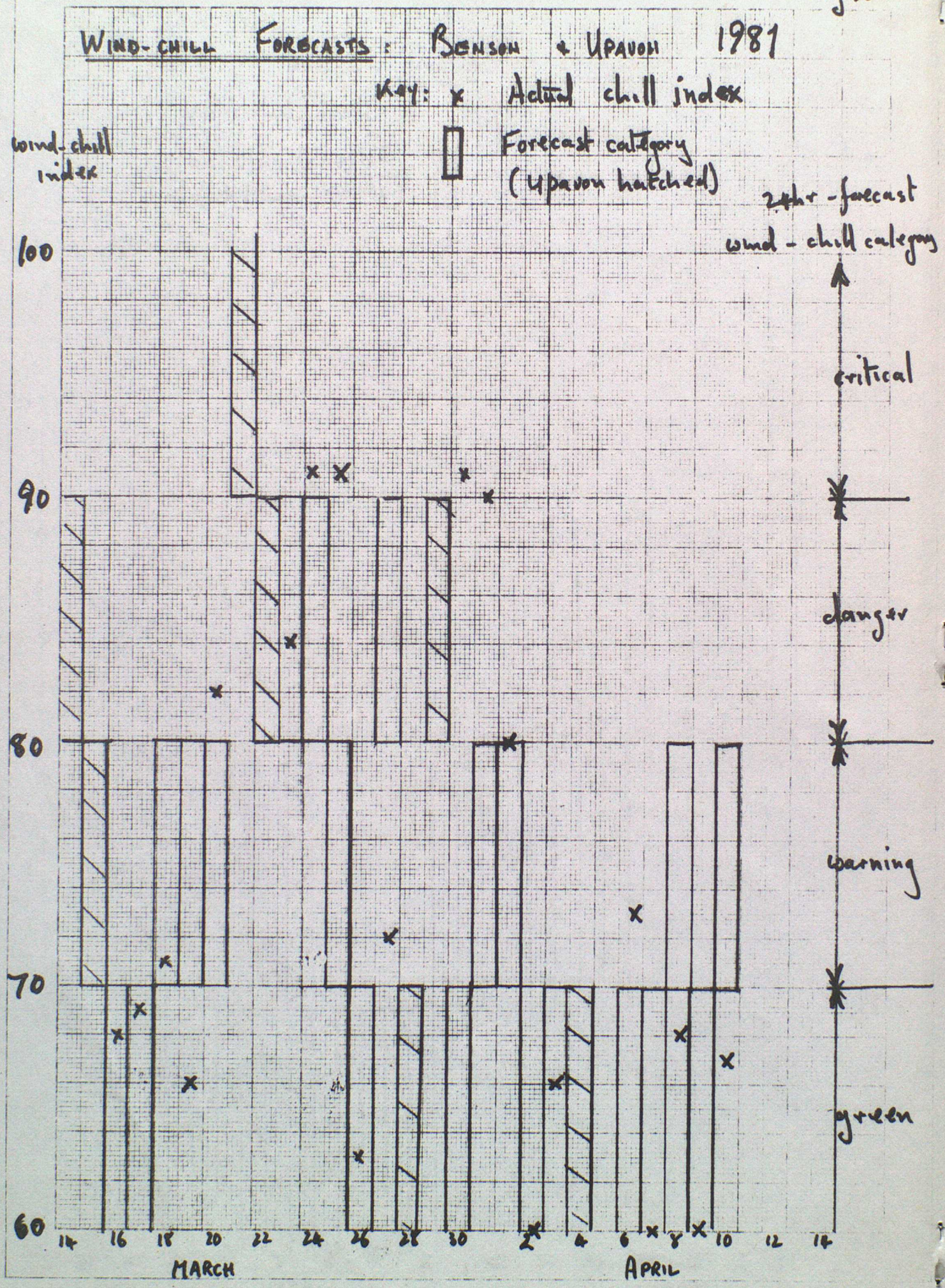

WIND-CHILL FORECASTS : BENSON + UPAVON 1980
Key : × Actual chill index
: forecast category (UPAVON hatched)
wind-chill index
24-hr forecast wind-chill category
100
90
80
70
60
critical
danger
warning
green
16 18 20 22 24 26 28 30 2 4 6 8 10 12 14 16
MARCH
APRIL

Fig 2


WIND-CHILL FORECASTS: BENSON & UPAVON 1981
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Forecast category (Upavon hatched)
wind-chill index
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green
14 16 18 20 22 24 26 28 30 2 4 6 8 10 12 14
MARCH
APRIL

Wind-chill indices for wet coat and dry coat

Table 2

Wind speed at Rushall (knots)	(a) Wet coat indices				(b) Dry coat indices		
	Temperature (°C)						
	>5	5 to 0	0 to −5	<−5	>0	0 to −5	<−5
>20	17	18	19	20	12	13	15
11–20	16	17	18	19	11	12	13
≤10	14	15	16	17	10	11	12

Forecast and actual wind-chill on 27th March 1980 for Rushall Farm

Table 3

Factor	Period (local time)						
	08.00 to 12.00	12.00 to 16.00	16.00 to 20.00	20.00 to 24.00	00.01 to 04.00	04.00 to 08.00	Total
Temp. (°C)							
forecast	10	10	10	7	7	7	
actual	12	11	9	7	6	7	
Windspeed (knots)							
forecast	15	12	10	10	10	10	
actual	15	15	12	8	4	10	
Rain							
forecast	yes	no	yes	yes	yes	yes	
actual	yes	yes	no	no	yes	yes	
*Wind-chill**							
forecast	16	11	14	14	14	14	83
actual	16	16	11	10	14	14	81

Table 4

Meteorological Office RAF Upavon

Forecast 'Windchill' Stress Factors for Newborn

Lambs at Rushall Farm, Bradfield, Berkshire

MARCH APRIL MAY 1981

Date 21-3-81

Period LT	0800 to 1200	1200 to 1600	1600 to 2000	2000 to 2400	0001 to 0400	0400 to 0800	TOTAL
Forecast temp °C	10	11	10	09	08	08	
Forecast wind speed knots	22	22	22	20	18	18	
Rain?	←		YES			→	
Forecast stress factor	17	17	17	16	16	16	99

VIGOROUS DEPRESSION APPROACHING U.K.
FRONTAL RAINFALL BECOMING INTERMITTENT
AT TIMES IN WARM SECTOR.
INDEX 99.

Passed to EL.
21/0077.